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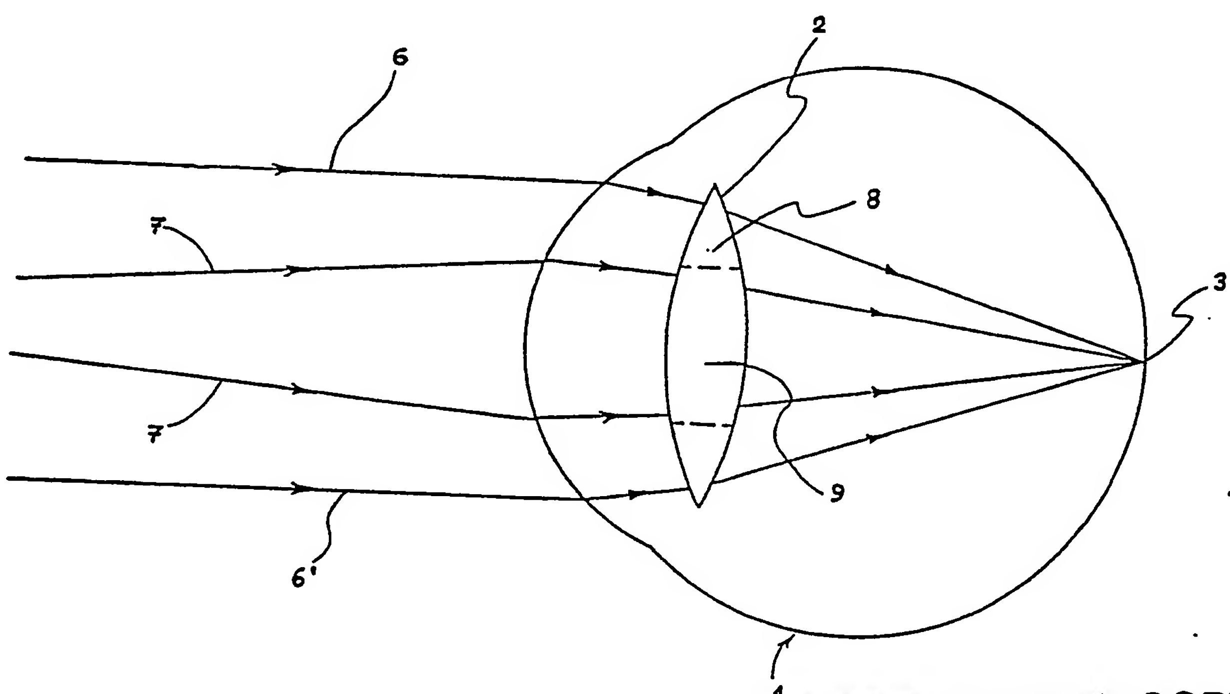
(54) Title: INTRAOCULAR LENS



(57) Abstract

An intraocular lens (2) with which the natural lens of the eye (1) is replaced in connection with, for example, a cataract operation. By using a bifocal intraocular lens which has advantageously two different focal distances (8, 9), two images are produced on the retina (3), one of the images being sharp at close distance (7, 7') and the other being sharp at long distance (6, 6'). The brain emphasizes the desired image.

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Intraocular lens

The invention relates to an intraocular lens to be fitted inside the eye.

The lens of the eye is usually removed in connection with a cataract operation. In this case the function of the lens has to be compensated for by means of, for example, spectacles or contact lenses. However, in this case the spectacles are very strong and therefore thick and heavy. The use of contact lenses is often also difficult, and owing to the irritation caused by them they are not suitable for all cataract operation patients.

Therefore in recent years the use of a so-called intraocular lens, a lens fitted inside the eye in connection with a cataract operation to replace the natural lens, has been started. The lenses are classified for example on the basis of the location of the lens, in which case the lenses are called chamber angle supported lenses, iris supported lenses, and posterior chamber supported lenses. In this case the attaching means fitted to the lens is supported by the respective chamber. The optical part of the lens is usually made of polymethyl methacrylate (perspex), either by turning or by casting. The lenses can also be classified on the basis of the material and design of the supporting loops or feet. The supporting loop or foot may be of polypropylene, either clear or colored, usually blue.

All previously known lenses are characterized by spherical optics, realized by means of convexity of the front surface or the back surface of the lens. These spherical intraocular lenses have the disadvantage that they form a sharp image at only one distance. Thus, if the lens has been

preoperatively designed to correct the patient's distant vision, the patient has to use reading spectacles in close work. Respectively, the lens can be designed to correct the patient's near vision, if the patient uses most of his time in, for example, reading, writing, or similar close work.

The object of the invention is to provide an intraocular lens which corrects the patient's visual acuity, both near and distant. Such a bifocal intraocular lens (BIOL) is produced according to the invention by dividing the lens into at least two parts with different refractive powers.

If, in accordance with the invention, the lens is made up of two parts, the first and the second part, the second part can be located in, for example, the center of the lens, on its main axis, in which case the first part is made up of the peripheral part of the lens.

The diameter of the lens is about 6 mm. In the above-mentioned case the central part is 1.8-2.3 mm. By this arrangement, there are produced on the retina two images, of which the brain emphasizes the more important, depending on the situation. According to the invention it is also possible to fit several parts in the lens, whereby respectively several sharp images are produced on the retina.

According to the invention, the first part of the lens is of a first material and the second lens of a second material, the refractive coefficient of the second material being different from that of the first. According to the invention, the second part of the lens is in this case advantageously a hole, cavity or depression formed in the center of the lens. The hole may extend through the lens, whereby a so-called pinhole is obtained. There need not

necessarily be a hole in the center of the lens, but it is possible to fit in it a sleeve parallel to the main axis of the lens, the sleeve forming the said pinhole.

The central part refracts close-distance light and the peripheral part longer-distance light, or vice versa. By changing the size of the central part it is possible to accomplish an optimal balance between the simultaneously visible long-distance and close-distance images.

It is also possible according to the invention to weight one eye for near vision and the other for distant vision.

According to the invention the lens may also be made aspherical, in which case the first part of the lens has a different refractive power from its second part.

The invention is described below in greater detail with reference to the accompanying figures, in which

Figure 1 depicts an eye with a conventional intraocular lens,
Figure 2 depicts an eye with a bifocal intraocular lens,
Figures 3-12 depict bifocal intraocular lenses which are divided into two or several parts having different refractive powers.

In Figure 1, the eye has been fitted with a conventional intraocular lens 2 designed for distant vision. In this case, rays of light 6, 6' coming from a long distance are refracted correctly to one point 3 on the retina of the eye. By contrast, rays of light 7 and 7' coming from a close distance are refracted to point 4 and form a blurred image in area 5 on the retina of the eye.

Figure 2 shows how the intraocular lens 2, which is divided into two parts 8 and 9, refracts both rays 6 and 6' coming from a long distance and rays 7 and 7' coming from a close distance, in areas 8 and 9, respectively, to one point 3 on the retina of the eye 1. In this case the brain can emphasize either the close-distance image or the long-distance image, both of them being seen sharp.

Figures 3 and 4 depict a bifocal intraocular lens which is aspherical, the peripheral part 8 of the lens having a certain focal distance and the central part 9 of the lens a different focal distance. Thus, also, two images are produced on the retina.

Figure 5 shows a lens in which a piece of a material having greater refractive power than the peripheral part 8 has been fitted in the central area 9. Thus, two different images are produced on the retina by means of a lens having an even curvature.

Figure 6 depicts a lens with a so-called pinhole fitted in its central area. This can be accomplished either by simply making a small hole through the lens, whereupon this hole serves as a lens in the manner familiar from the pinhole camera. In this case the peripheral part 8 constitutes the second part of the lens, having a different focal distance. The pinhole can also be produced by means of a tube 10 inserted in the center of the lens, the tube delimiting the pinhole area 9.

The lens according to Figure 7 is divided into many parts which are located concentrically around the axis of the lens. In this case every second part 11 has mutually the same focal distance and every second part 12 mutually the same focal distance. In this case, for example, the parts

11 can be fitted for near vision and the parts 12 for distant vision.

The lens in Figure 8 is also divided into several areas, these areas being in alternation radially. In this case, area 11 can be fitted for distant vision and area 12 for near vision.

Figure 9 depicts a lens in which the curvature of the lens changes continually. Thereby a continual focussing precision at different distances is accomplished.

Figure 10 depicts a diffraction-type lens. In this, concentric rings are formed in the lens, the thickness of the rings decreasing by an amount which corresponds to the optical distance of half a wavelength. Thus the semi-wave areas 13 and the whole-wave areas 14 produce two different images on the retina of the eye.

By using the so-called "Fresnel" lens according to Figure 11 it is possible to reduce the thickness, and thereby the weight, of the lens. In this case, concentric Fresnel prisms 15 are used, their prismatic refractive power increasing outwards in the lens.

The lens according to Figure 12 is divided into two parts 16 and 17 having different focal distances, the parts being located in such a way that the lens is divided radially into two parts.

Claims

1. An intraocular lens to be fitted inside the eye, the lens being made up of at least two parts having different refractive powers.

2. An intraocular lens according to Claim 1, the lens (2) being made up of two parts, the first part (8) and the second part (9).

3. An intraocular lens according to Claim 2, in which the second part (9) of the lens is located in the center of the lens, on its main axis, and the first part (8) of the lens is located peripherally around the second part (9).

4. An intraocular lens according to Claim 2, in which the first part (8) of the lens is of a first material and the second part (9) of the lens is of a second material, the second material having a refractive coefficient different from that of the first material.

5. An intraocular lens according to Claim 3, in which the second, central part (9) of the lens is a hole (9), cavity or depression formed in the lens, or a piece of another material embedded in it.

6. An intraocular lens according to Claim 3, in which the second, central part (9) of the lens is a hole which extends through the lens, a so-called pinhole.

7. An intraocular lens according to Claim 2, in which the lens is aspherical, the first part (8) of the lens having a refractive power different from that of its second part (9).

8. An intraocular lens according to Claim 2, in which the lens is divided radially through the center in such a way that its first half makes up the first part (16) and its second half makes up the second part (17).

9. An intraocular lens according to Claim 2, in which the lens is divided into several sectors, every second part (11, respectively 12) having the same focal distance.

10. An intraocular lens according to Claim 2, in which the lens is divided into substantially concentric parts, every second part (11', respectively 12') having mutually the same focal distance.

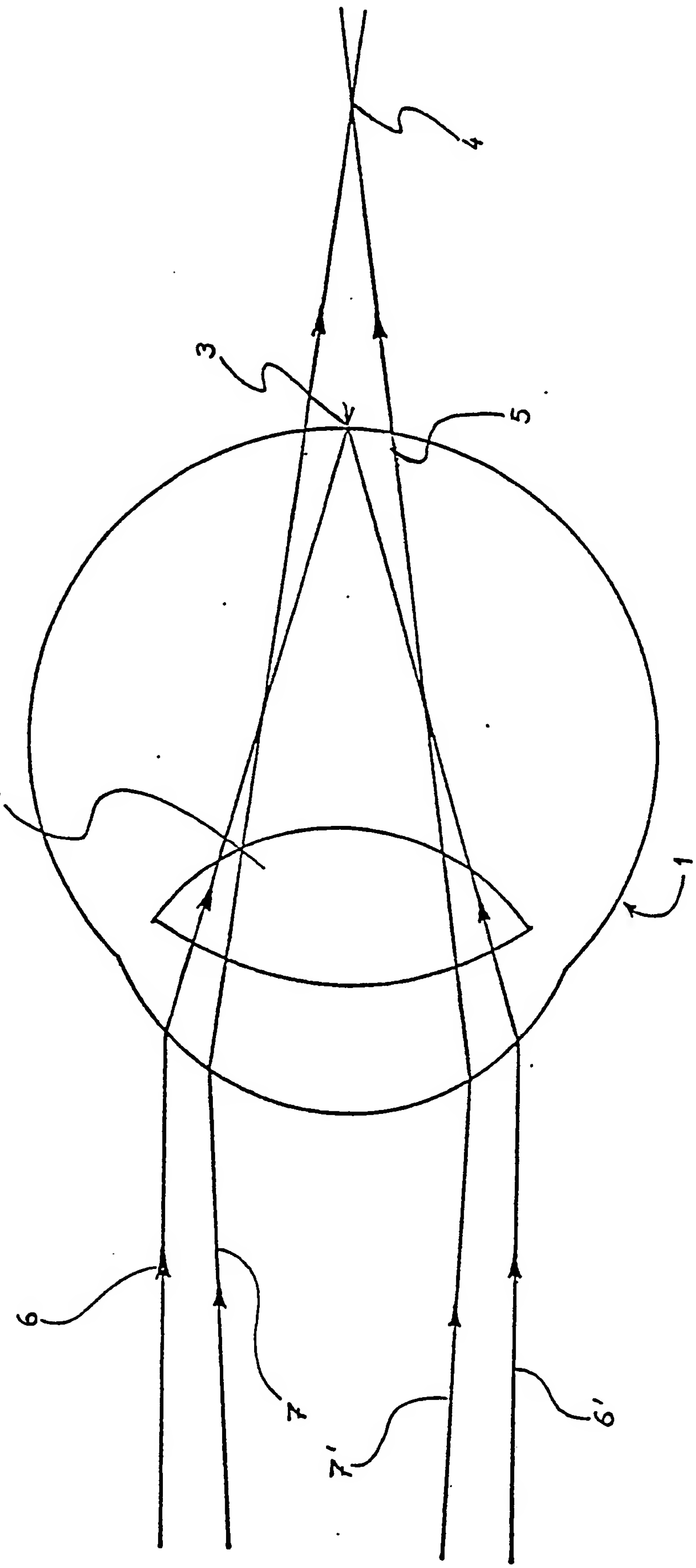

Fig. 1

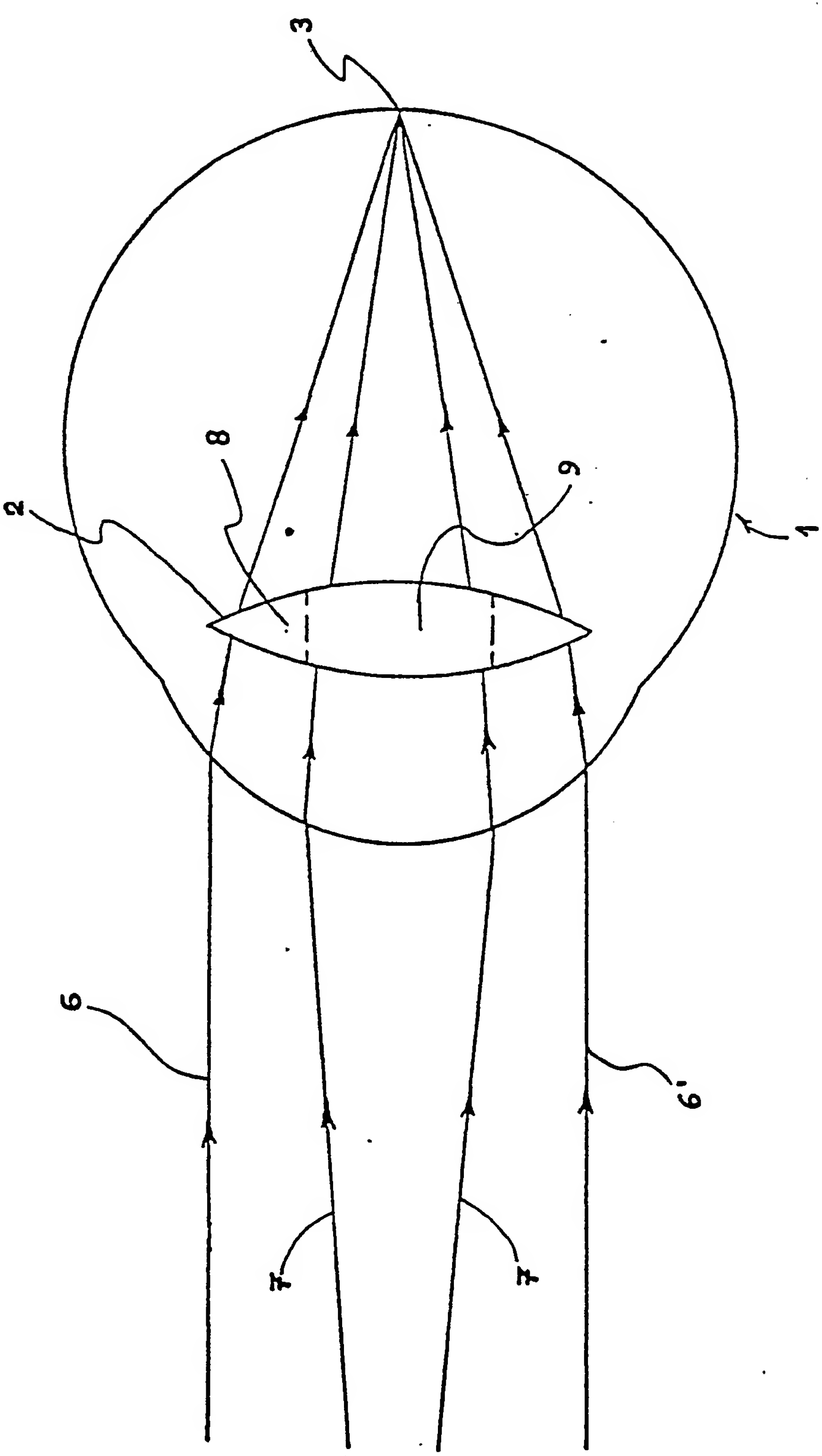

Fig. 2

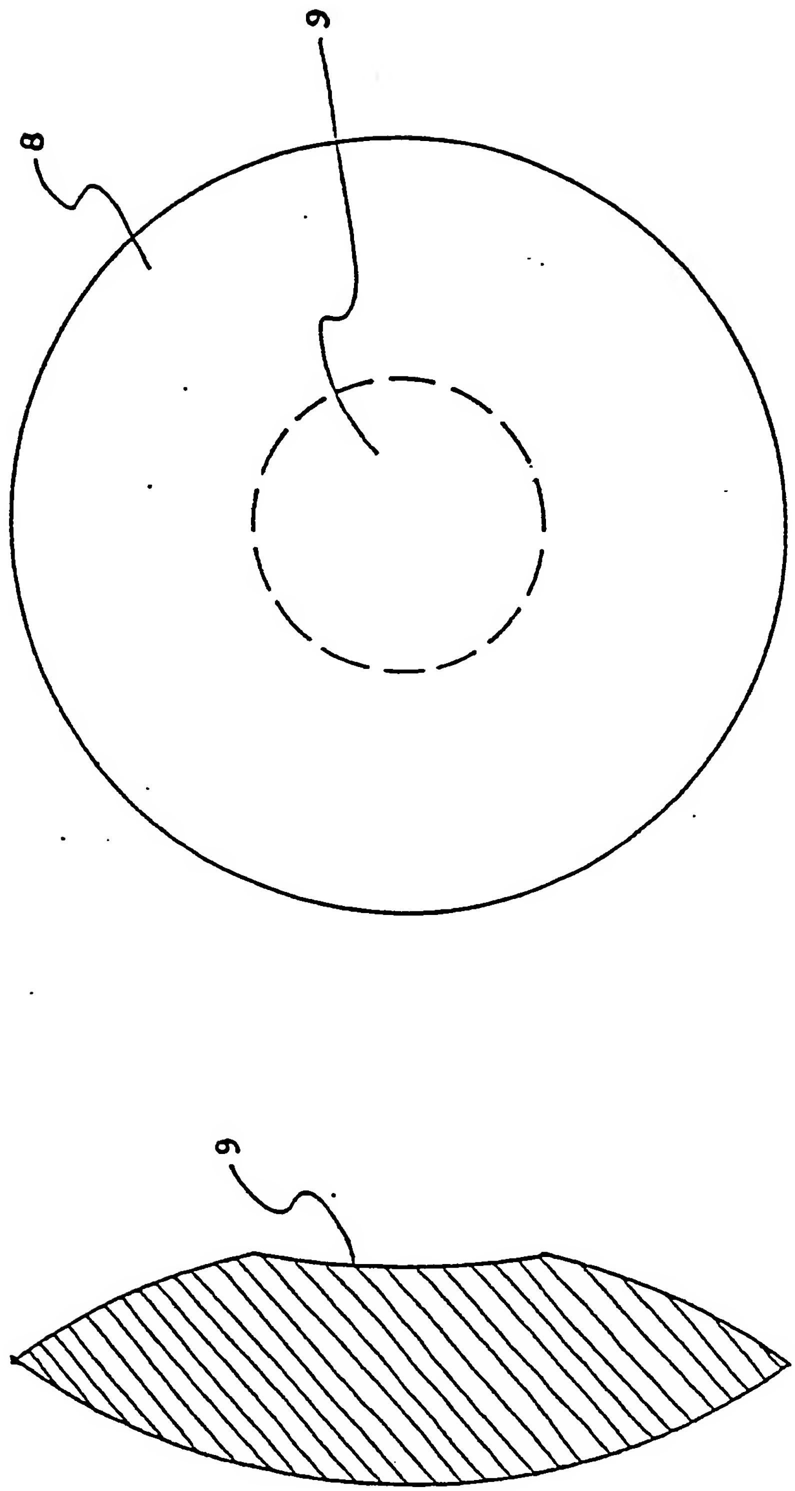

Fig. 3

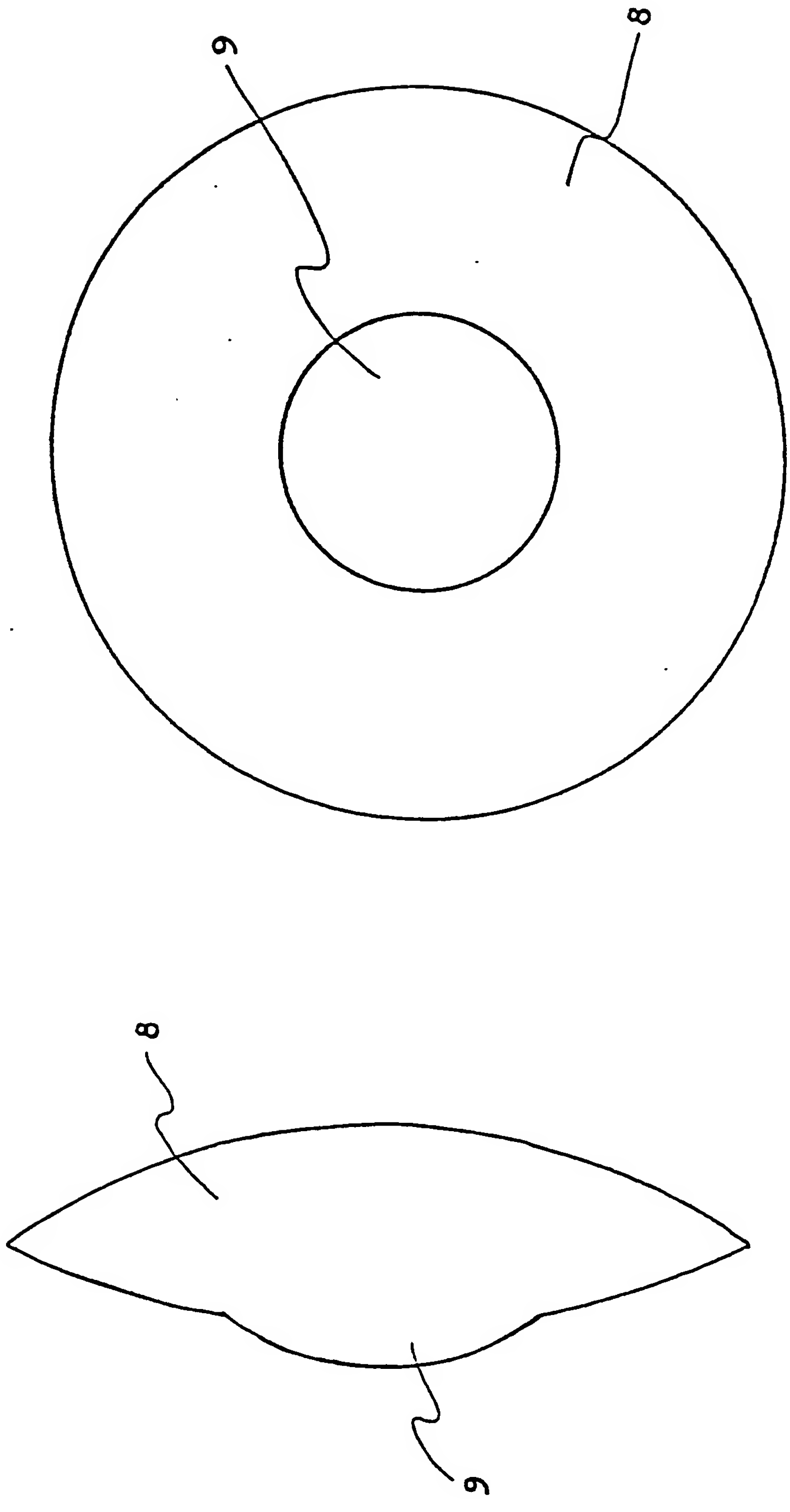

Fig. 4

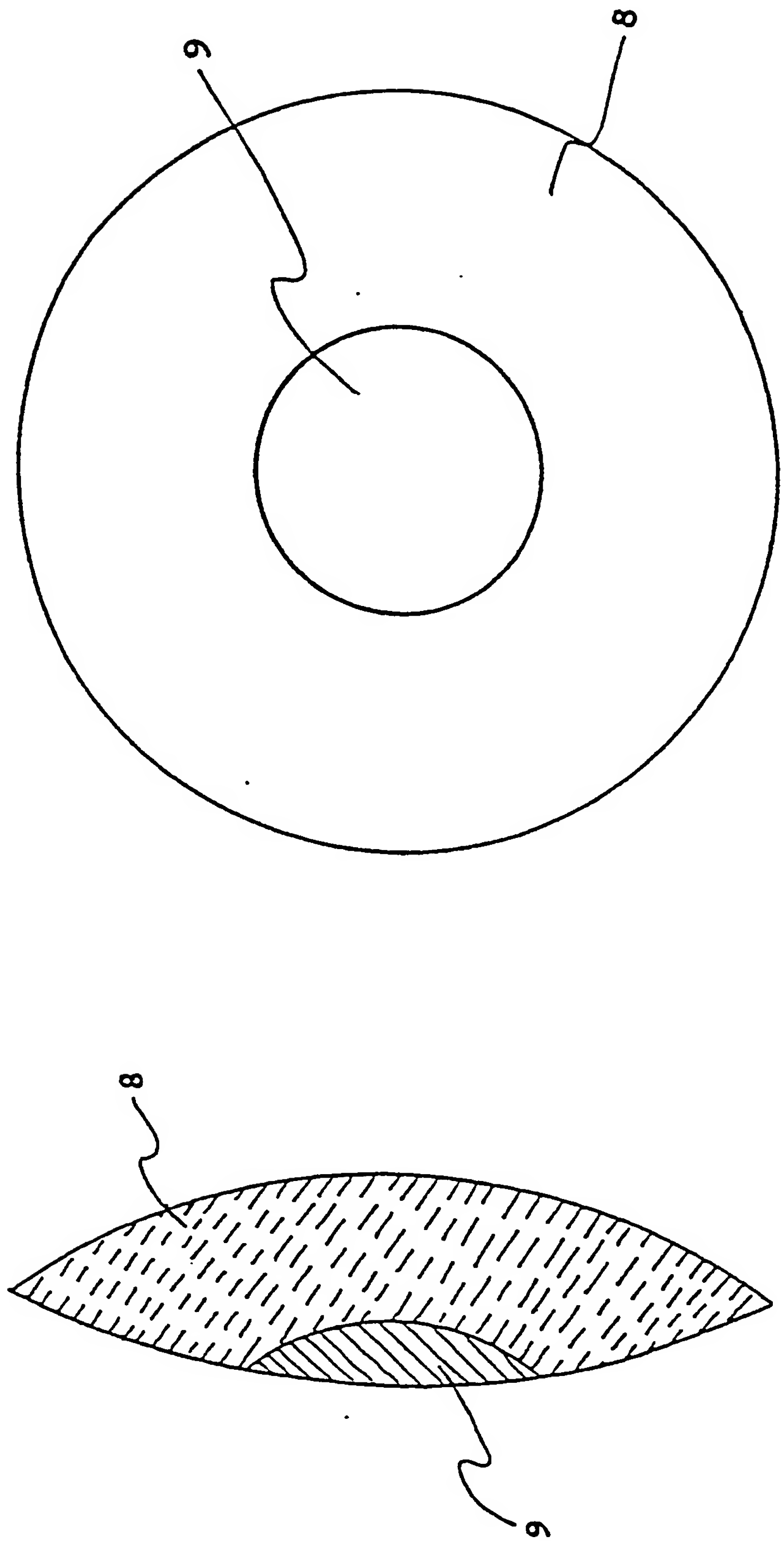

Fig. 5

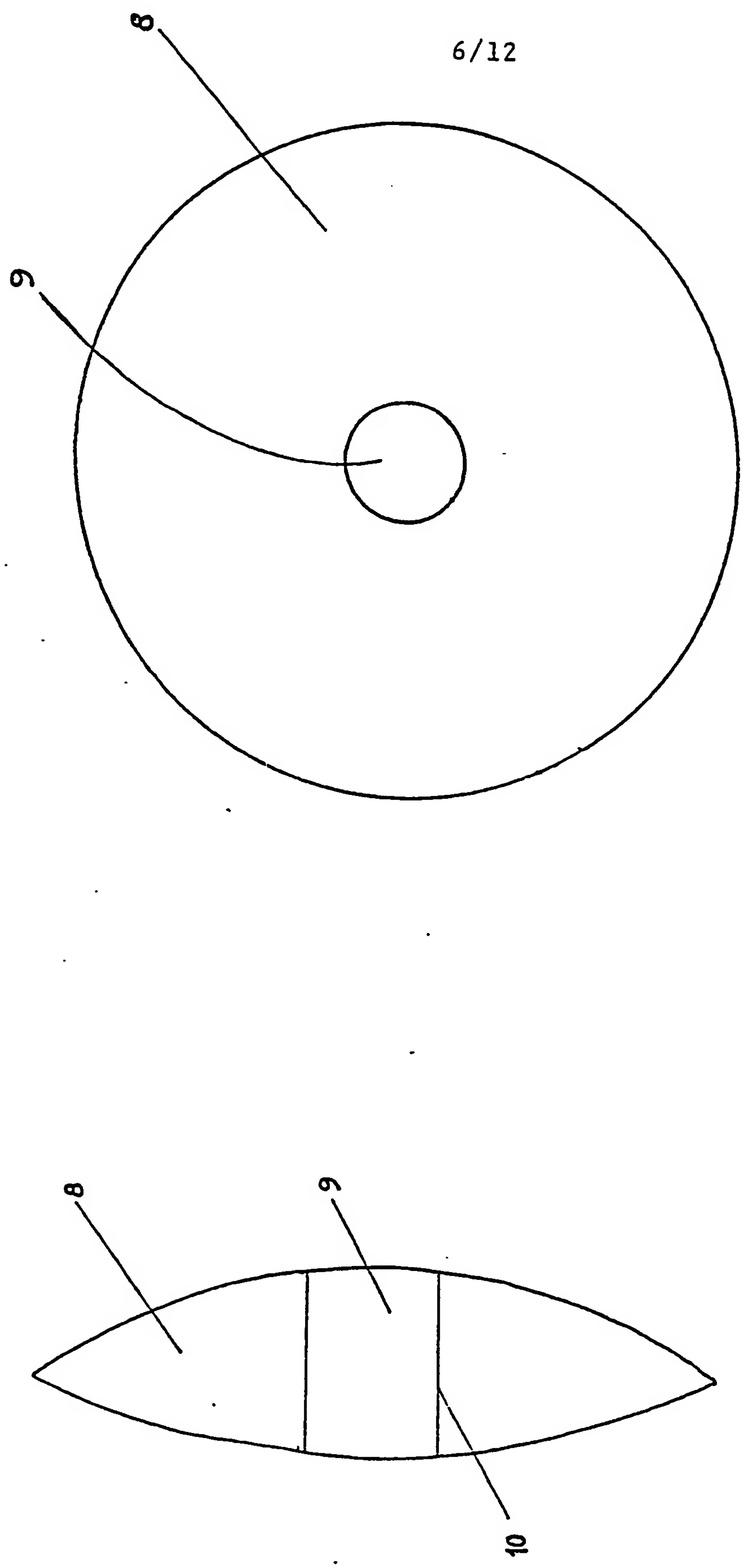

Fig. 6

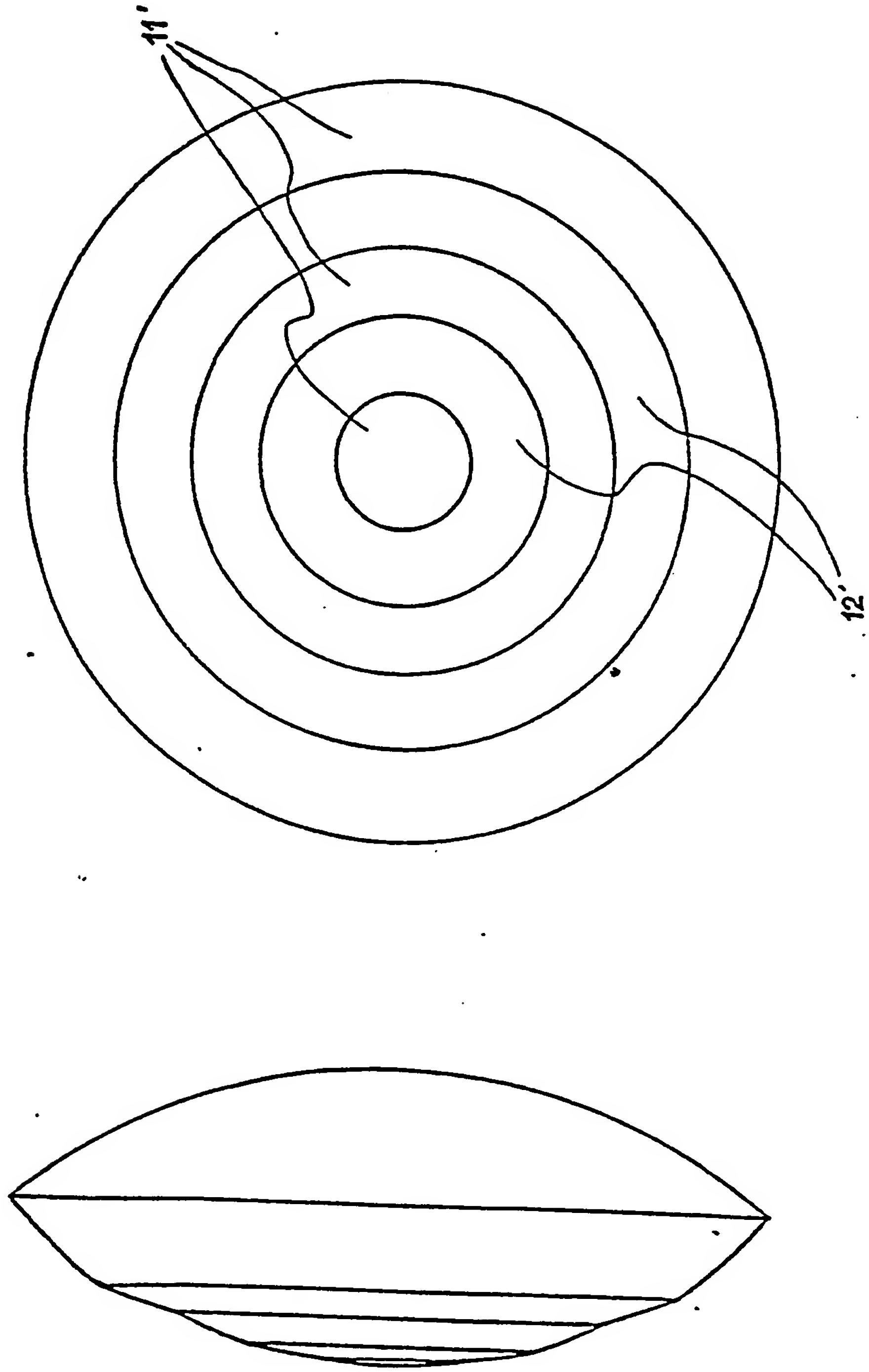

Fig. 7

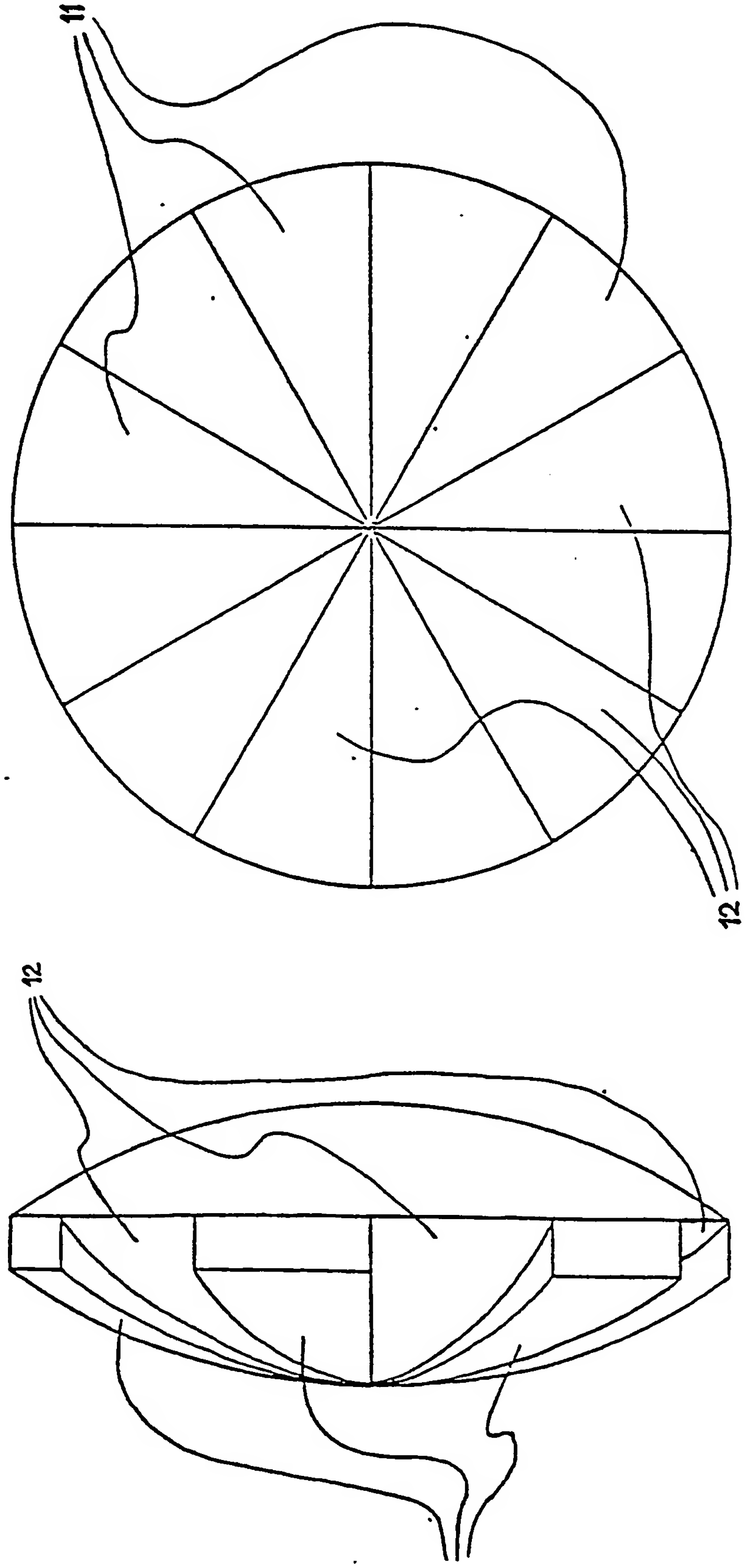

Fig. 8

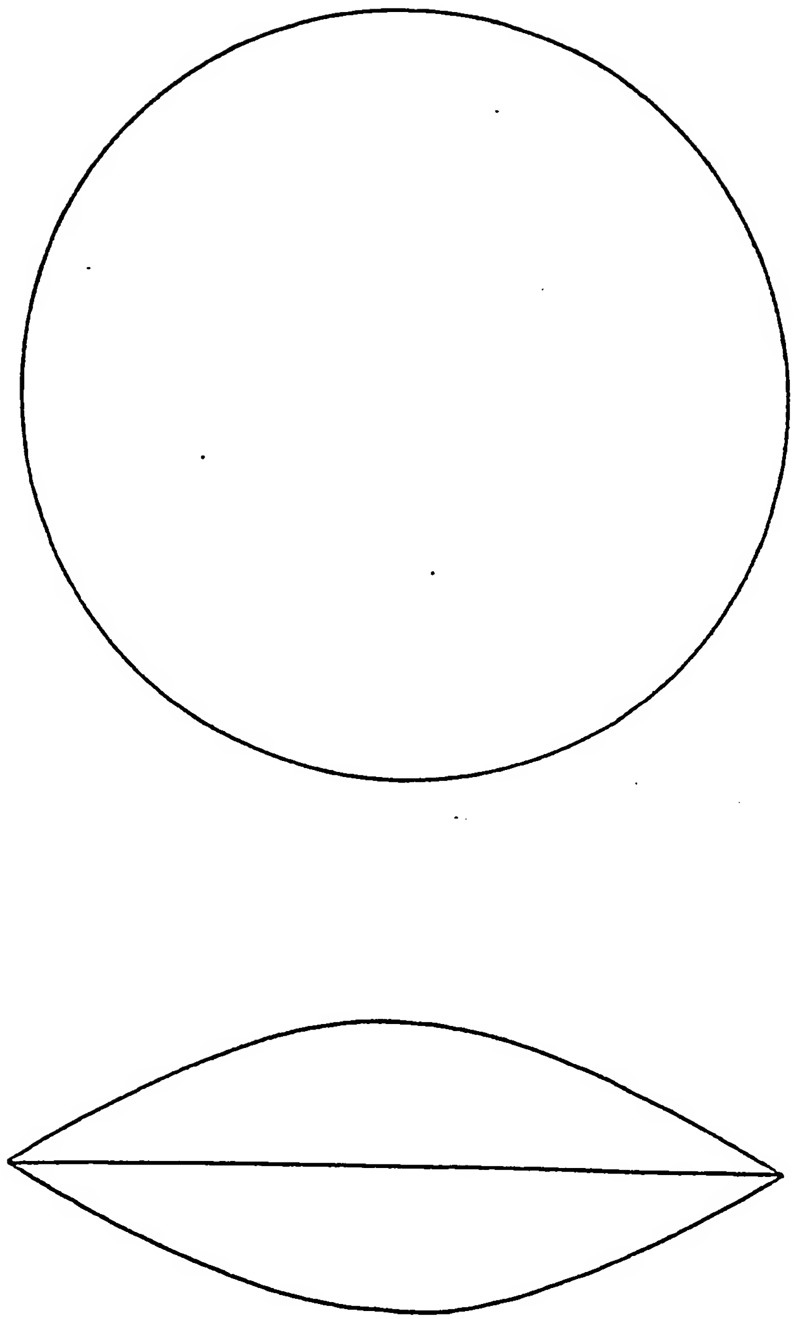

Fig. 9

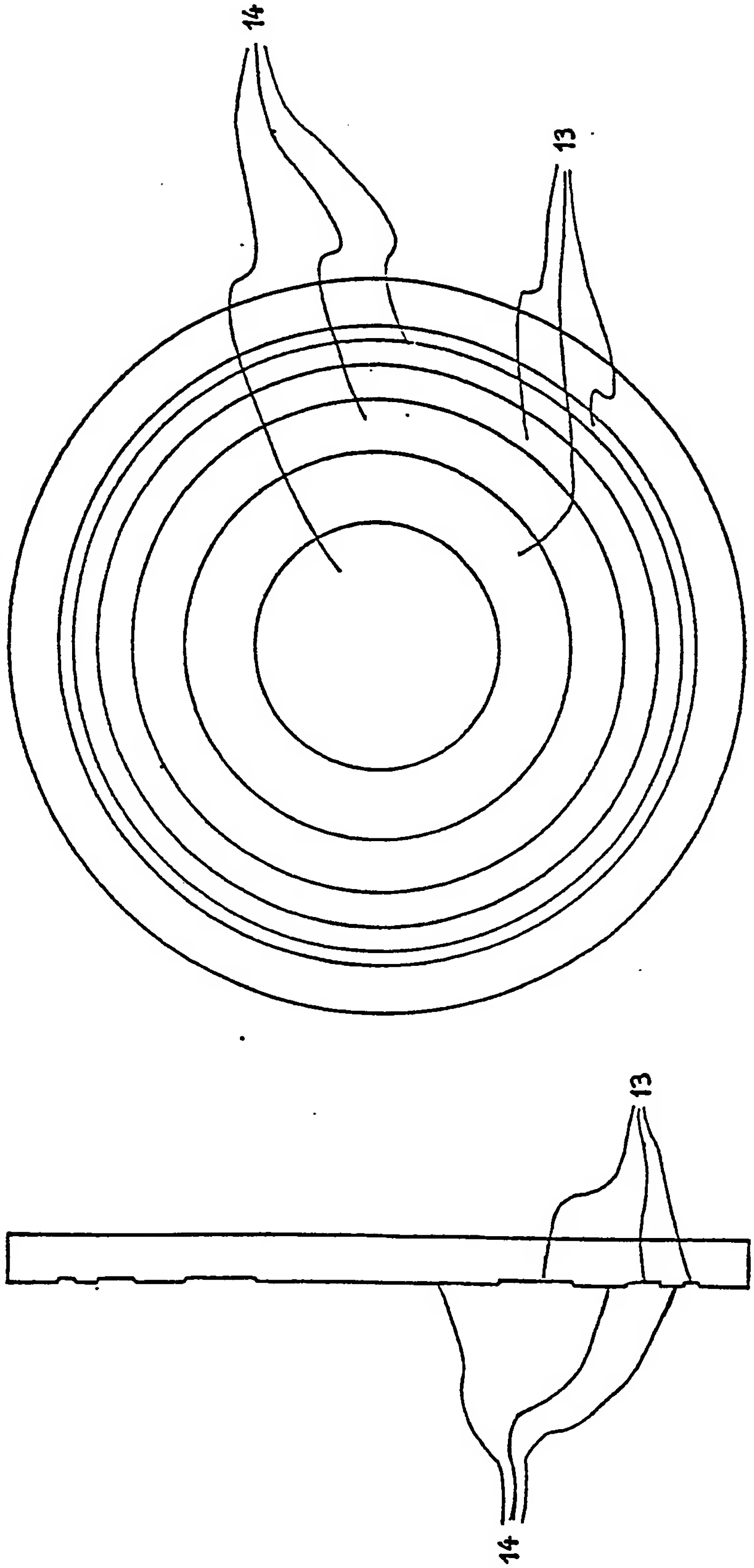

Fig. 10

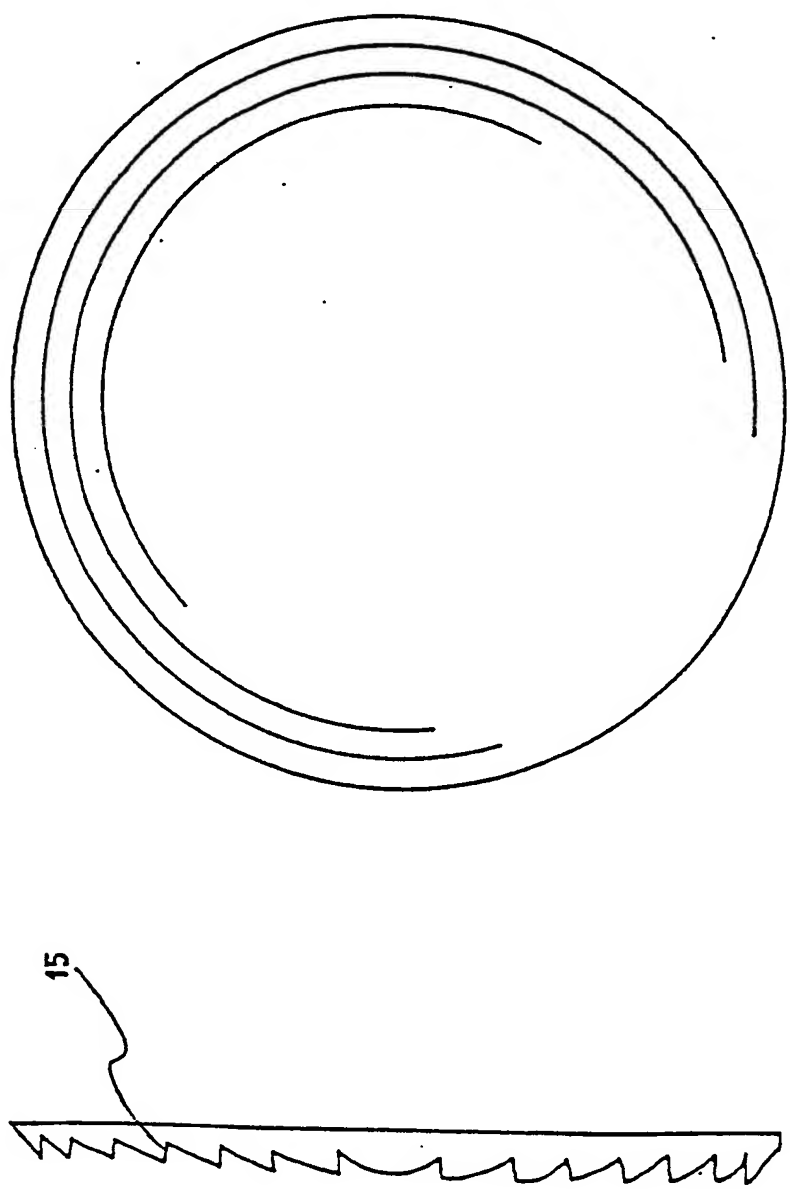

Fig. 11

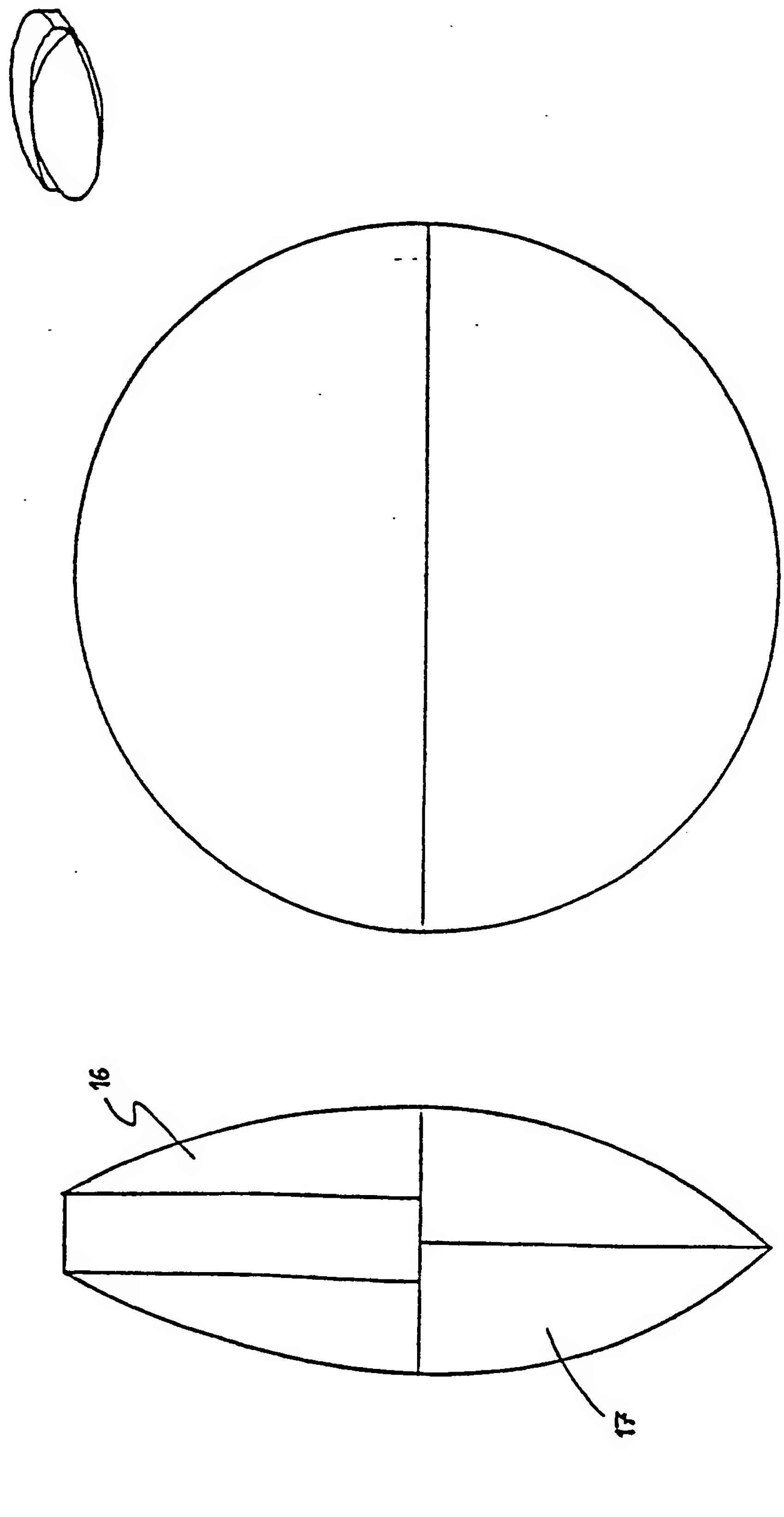

Fig. 12

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI85/00103

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

A 61 F 2/16, G 02 C 7/04

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	A 61 F 2/16; G 02 C 7/04, /06
IPC 3	A 61 F 1/16
US Cl	351:161, 167; 3:13

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
P	DE, A1, 3 332 313 (TITMUS EUROCON KONTAKT-LINSEN GmbH) 4 April 1985	1-10
X	EP, A1, 0 094 158 (LESPERANCE, F A) 16 November 1983 & JP, 58190439 US, 4435856 CA, 1190703	1,2
X	GB, A, 2 105 866 (LYNELL MEDICAL TECHNOLOGY INC) 30 March 1983 & FR, 2510768 DE, 3228352 US, 4450593 US, 4473434 CA, 1192069 JP, 58065412 US, 4402579 US, 4466858	1,2

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1986-03-17	1986 -03- 26
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Kristina Rilton

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
Y	GB, A, 2 129 155 (N G TRUSTEES & NOMINEES LTD) 10 May 1984 & EP, 0107444 JP, 59146020	4,7,9,10
X	US, A, 4 010 496 (NEEFE) 8 March 1977	1,2
P	US, E, 4 512 040 (McCLURE) 23 April 1985	
Y	US, A, 3 037 425 (DE CARLE) 13 November 1962	3-7
Y	US, A, 3 279 878 (LONG) 18 October 1966	8